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Recommendation on Priority Subjects for future RN-SHP Expert Group Meeting/Workshop

In the development of small/mini Hydro Power for a developing country in particular, the main aspect that should be considered would be whether the country is willing to develop the technology in line with the country's energy requirements, as well as, its capability in adapting foreign technologies to suit its priorities. Otherwise the venture can result in very expensive systems and may be in the end, be a failure, putting the country into debts unforeseen in the first instance. As such, there are several areas which should be considered after small/mini hydro is adopted by a country. Mini hydro development and technology can only be acquired by experience. From this statement, pilot and trial projects are necessary to gauge the ability of available manpower resources of the country, in handling such projects especially if large scale implementation is desired. In Peninsular Malaysia trial ad pilot schemes have presented new outlook into the issue. The areas that need to be studied in detail are the following:-

a) Current Civil designs in areas having high rainfall and high incidence of land slides

In Peninsular Malaysia, in particular, the tropical rain ,especially, in the monsoon season spans many months, can result in the earth in hillside areas to be water logged. Landslides are frequent and these can have disastrous effect on the total Mini Hydro Power Station system. Landslides normally occur at strategic positions e.g. cutting roads leading to Power Stations, landslides at pipelines anchor blocks, landslides at pole or tower position of transmission lines, landslides remote but at a higher level than the Power Stations and pipelines causing large rocks rolling down and damaging some parts of the system etc. The study in this area can mean:-

i) Changes in designing of anchor blocks for pipelines e.g. having deep rooted pole structures rather than flat boxes.

ii) Ensuring proper anchoring of Mini Hydro Power system i.e. the pipelines and the Power Station anchored to solid immovable rock structures if available.

iii) The building of specially designed non-metallised roads at specific locations with proper drainage.

iv) Studying the landslide phenomena and its reduction; say the planting of deep rooted trees at strategic positions.

The overall effect of this would mean that in putting up a Mini Hydro Station a bird's eye view of the terrain forest and

fauna and geology have to be looked into from the mentioned problem.

b) Hydrology of tropical forest areas and the factors affecting these due to deforestation and the recovery of the total system thereafter.

Where logging activities take place, hydrology in tropical forest alters tremendously. Recovery of the affected area takes some time but due to its inherent nature, recovery can be considered rapid. The change in hydrology can be seen due to the initial clearing of the area and the subsequent growth of small plants. The total picture of the situation means on the onset of logging activity, large amount of silt, branches logs and leaves are brought down by the river affecting the Mini Hydro system. Flood levels are high and may result in drowning of the Power Station. The high siltation shortens the life span in pipelines and turbines. The recovery of the system depends upon the type of plants that covers the bared areas and this can possibly emphasises proper replanting of trees in exposed areas of the forest.

c) The effects of mining and development causing sendimentation and high suspension in water system meant for Mini Hydro projects.

In Peninsular Malaysia mining industry is extremely active and mining can be in the form of opening of large areas or can be digging up of river beds on small scale by illegal miners. The building of roads and open spaces simultaneously with deforestation have caused large amount of sendiments to appear in the water system. The abrasive nature of the products of these developments are disastrous in the Mini Hydro projects. Controlled mining is necessary to keep the water from being polluted. There is a need to look into the means of reducing sendimentation caused by such activities.

d) Methodology of transport of materials and equipment to site

Transport to site of materials and equipment has been a problem in this area especially during the rainy season. Terrain at times does not allow use of vehicles and the heavily forested area makes it difficult to transport material by means of helicopters. As the cutting of trees is discouraged, methodologies have to be developed for the transport of material and equipment into such areas. Excessive earth movements mixed with the tropical rain can be a hazard.

e) Construction methods using cable systems

From experience, it was found that the best system of construction in this area is using cable systems for transport of pipes, cement, steel and all constructional material necessary at site. The cable system stretches from a convenient location of storage of material and covering the total Mini Hydro system

i.e. from the weir to the Power Station. Methodologies have to be developed considering every site is peculiar in its contours and anchoring methods have to be developed in such cases. Standardised system can be created for all Mini Hydro sites.

f) Type and design of machinery to be used in implementation of projects and the minimum number of equipment that can be used in construction.

In putting up Mini Hydro stations the difficulty in transportation of materials to site means the need to design specific equipment for such system. The number of equipment used in construction should be minimised and if implementation on a large scale is to be carried out, studies into the topic is necessary to cut down costs of construction.

g) The training of manpower for constructional purposes

Working in remote areas having difficult terrain in the tropical jungle, as well as trying to introduce a technology in the remote area, the training of manpower for constructional purposes is essential. The handling of tools and equipment in difficult areas with makeshift construction pads and dangerous situation means the need for such training. The men should be trained for difficult terrain work apart from normal training in constructional methods. The training involves climbing, working suspended in mid-air, working along cliffs, working on river beds, etc.

h) The method of building roads to Power Station.

The building of roads to Mini Hydro Power Stations is not easy due to the terrain and nature of land in this country. There is a lot of experience to be gathered from loggers who build loggers tracks that seem to have lasted for many years. The roads to Power Stations have been thought to cover minimum requirements only, and are subjected to landslides and also the rapid growth of fauna can mean slippery and unreliable roads. The maintenance of such roads can be expensive and as such, the design of such roads have to be looked into bearing in mind that capital spent is small, in order to place project outside the economic constraint of the financing agency.

i) Fitting designs to environment minimising blasting cutting of trees and steps to be taken to avoid danage to pipe lines from fallen trees.

The environmental effect of cutting down trees and blasting of rocks is normally not called for, as disturbances to the environment is highly undesirable in this country. Designs of Mini Hydro systems have to fit to the environment. The cutting of trees have to be avoided and damage to pipelines from fallen trees have to be looked into. The nature of tree falling in the jungle is an unknown phenomena and can be caused by winds, animals or age. Trees close to pipelines seldom damage pipelines

but those further away seem to have more effect. It can be deduced that the height and type of tree and its distance from the pipeline and power station have a strong bearing on degree of damage that these trees can do. Minimising of blasting is essential to cut down the security constraints of construction in such areas in this country.

j) Effect of flooding and generation of electricity while under flood conditions.

In the event of flood occuring it is usually that the wiers and connecting intake area of the Mini Hydro Power Station is covered with water. The tailrace water level at the Power Station rises resulting in overall decrease in head available for power generation. Decrease in head result in inavailability of the Power Station to generate sufficient power and there may be vibrations and fluctuations in the overall system due to this. Power Station foundations are subjected to severe errosion and backwater effect due to constriction of the river downstream from the tailrace. The operation of power station under flood conditions need to be studied as in Peninsular Malaysia floods occur very frequently.

k) Effect of water hammer on pipelines.

Water hammer on pipelines in Mini Hydro systems occur only when the Power Station machinery is subjected to sudden stoppage or due to a sudden closure of the main valves. Water hammer can also occur during the operation of the machine due to the inherent characteristics of the machinery. A study in the effect of water hammer on the pipelines and its solution is essential for the protection of the pipeline and the machinery. Each Power Station is peculiar in this aspect and means of correcting this phenomena is necessary, in order to extend the life span of the Mini Hydro system.

l) Machinery design and seed designs for manufacturing.

In order to reduce costs, it is necessary for countries to manufacture their own turbines where possible. There is a need to produce seed designs as these form a basis for design or other sizes needed. The design of the machinery must take into consideration the capability of the country in terms of local manufacturing especially where precision is demanded. A venture in this area can have vast implications on the future of manufacturing in an undeveloped country.

m) Simplification of turbine governors of load ballast type and electronic types.

Current types of governors, mechanical or electronic are complex in nature and requires skilled workmanship in developing them. There is a need to simplify such governors in order to reduce its cost , bearing in mind also that the degree of precision influences the standard of the electrical power

generated Hybrid designs are recommended and may be a solution to many areas of governor design.

n) Machine transportation, installation and commissioning.

The transportation of machinery to Mini Hydro stations as well as its installation and commissioning demand certain skills.It is essential to ensure that this is correctly done possibly through a system checklist and a guide manual of procedures in handling machinery, checking of levels, dynamic testing, etc. Some degree of training is required in this area especially where larger systems are being installed. The safety aspects of machinery training installation and commissioning must be stressed to avoid mishaps to personnel involved and to ensure long life to turbine and generating machinery. Simplification of the total machinery installation by having the whole power station in preassembled containers is the target. This can be an interesting aspect for study.

o) Fault of generating systems and their protection methods. Computerised control of machine operation, remote sensing for remote operation.

In the long run Mini Hydro generating systems can have faults and in such cases the protection system must be adequate to prevent damage. Where a large number of Mini Hydro Power Stations have been established computerised control of machine operation may be necessary especially in the area of remote sensing for remote operation. This is to cut down manpower as well as to increase reliability of centralized control of these Power Stations as their contribution has a considerable effect on the Grid system.

p) Transmission and distribution designs, Grid connections and reliability of systems.

The transmission and distribution of the electrical energy where the Mini Hydro Station is connected to the Grid can determine the reliability of the total system. Where a large number of Mini Hydro stations are connected to the Grid and they represent considerable value of power input to the Grid, the sum effect of these Stations to the Grid system is large and must be studied from total power generation point of view. Assessment must be made on the reliability of the system, the stability of the system, the effect of faults in large power stations on the operation of these small stations, the effect of voltage swings etc.

q) Social and economic effect of small/Mini Hydro systems.

On the establishment of Mini Hydro power generating system the social and economic effect of the benefiting rural population must be taken into account in order to quantify what was earlier considered as intangibles contributed by such power stations. The social and economic studies will determine the rate of growth

of the area, the contribution of the generating station as a nucleus or development, as well as, the future projections in order to cater for demands of the area. The implication of such a system for rural population must be considered.

r) User of tailrace water for irrigation and drinking water.

Water available from Mini Hydro Power Station i.e. from the tailrace can be used for irrigation or drinking water for the rural population. In each instance study can be done especially on the design and type of water collecting intakes for these purposes. Methodologies to effect these systems must be considered in order to obtain the maximum benefit for the rural area as well as minimising its effect on power generation by the Mini Hydro stations.

s) Pricing of electrical energy when connected to the Grid for economic/financial evaluation purposes.

In evaluating a Mini Hydro station, the pricing of electrical energy must be considered for the economic and financial evaluation of the system to determine availability of the projects and the degree to which the project can recover capital investments injected into it. The pricing of electrical energy is normally inadequately done especially in small Hydro Stations or run river types when these are compared to major Hydro installations. Pricing of the electrical energy transmitted to the Grid must be looked into in order to testify that these Stations prove economical. Methodologies and approach of the pricing system should be laid out so that each country can evaluate its Mini Hydro Stations, as well as, to determine the size of the loan needed from international banks. Proper pricing should also ensure that the benefits obtained are real and will not unnecessarily put a country into debts which it cannot afford. An international agreement on this matter and its approach is necessary . International banks must be convinced of the approach to pricing of the electrical energy generated by Mini Hydro power stations.

t) The effect on Mini Hydro of agricultural development upstream on ungazetted catchment area.

Having installed the Mini Hydro Stations, it is expected that the rural population would increase activities to enhance living standards. There is a possibility that increased agricultural activity will result in development upstream especially on ungazetted catchment areas. The social and economic effect including the effect on the power stations must be looked into, to ensure certain possibilities to be included. In certain undeveloped countries such an incident may not be avoidable, but steps must be taken to ensure minimum effect is seen on Mini Hydro station already built. There may be a need to gazette catchment areas but there is also a need for the rural population to prosper and feed themselves by the use of these areas discriminatingly to ensure that the total ecology and well being

of the catchment areas and the Mini Hydro Power Station is safe from undesirable effects.

u) Types of new Mini Hydro system and research work into these areas.

Innovation and new designs are necessary to produce machinery and systems that can harvest water energy to the maximum. Current designs are limited and can only harvest water designs above a certain head. Research must be done to look into these areas of harvesting water energy to the lowest level and at the highest efficiency. Different turbine designs and new concepts have to considered, as not all the terrain along a river has adequate potential head. Energy in free flowing rivers with no head are enormous but cannot be harvested at the present moment. Efforts have been made to create new engines but insufficient enthusiasm is currently predominant. The aim is to increase the efficiency of the total system with maximum harvest from these rivers.

Priority areas for Joint Research Project

Priority areas should include:-

a) Study into the use and manufacture of the crossflow or Banki turbine for medium and low read Mini Hydro Power Stations

The crossflow or Banki water turbine has been known for many years to be a versatile turbine, easily manufactured, but, unfortunately has a relatively low efficiency when compared to the Franicis turbine or Pelton Wheel. It is known that only one manufacturer has been able to raise the efficiency of such a turbine to value comparable to that of the Francis. This means that it is possible to develop a crossflow turbine that has a high efficiency. The ability of the crossflow turbine to function over a large range of heads as well as over a wide range of flow of water, makes the turbine an essential item in the development of Mini Hydro technology in the developing countries. The fact that the turbine has minimum casting requirements and can be easily fabricated in small Workshops makes it more reasonable for developing countries to venture into the manufacture of this type of turbine. Unfortunately, little work has been by Institutions on the turbine other than those done by private enterprise. It is suggested, therefore, that work in this area be considered to take advantage of the inherent simplicity of the machinery and its capabilities as a Mini Hydro turbine. Malaysia has acquired the designs of the basic turbine from OLADE and is in the process of developing the turbine for use in this country.

b) Joint research into the development of turgo impulse turbine for medium and high head designs.

The turgo impulse turbine is a hybrid and links the

operational field of the Francis turbine and the Pelton Wheel. Castings or fabricated turgo impulse wheel are easily made and this turbine can be developed easily for use in developing countries. The fact that it covers a large range of operation from that of the crossflow turbine to fringe areas of the Pelton wheel operational chart gives this turbine an advantage over the Francis turbine. The complexity of the Francis turbine gives the turgo impulse wheel a definite edge over it. Development of this particular turbine therefore completes the scenario of development required in the turbine area.

c) Research into governing systems for Mini Hydro Stations that includes load distribution, ballast load system.

The governing systems for Mini Hydro Power machinery determines the reliability and standard supply available to the rural consumer. Currently developing governors are based on complex design and there is a need to develop governors either mechanical, electronic or hybrid types for the Mini Hydro turbine. Research into this area can be very fruitful if steps are taken to use alternative parts from tractors and motor car as parts in the governor design. An alternate and appropriate design using available parts would mean low cost development programme for developing countries in this context. Maximum use of these parts should be considered bearing in mind that these parts are available at low cost due to mass production. The use of electronics in the governing system should be minimised where possible as spare parts becomes the issue in the long run.

d) Research into the systems for energy utilisation and use in rural areas such as hot water system, refrigeration systems.

The generation of electrical energy in the rural area would not be helpful to the rural consumer if the energy is limited in use for lighting, radio and T.V. only. As a nucleus of development Mini Hydro energy must be used wisely in a manner to augment the progress of the rural sector. Research into the area of energy utilisation and use in the rural area for hot water system, refrigeration, electrolytic use in agricultural industrial and rural sectors must be considered.

e) Use of water resistance for testing of Mini Hydro turbines.

The testing of water turbines requires loads to be varied over a large range of the water turbine generating systems, loading. The problem of transportation of large banks of resistors for commissioning makes it necessary to use water as a variable resistance representing the loads for testing purposes. Research into the use of water as well as the design of the rigs to create water resistance and the safety aspects can be looked into in order to minimise transportation problems. Current turnkey pojects in the Malaysian Mini Hydro programme makes use of water resistance for loading purposes and it has been found that there is a need to better design and increase safety features.

f) The methods of supply to rural villages using battery charger systems.

For certain developing countries having populated areas very remote from town centres but where a small hydro station can be put up the output from the system may not be able to cater for the number of potential consumers. As such, a method of supplying these areas using the battery charger systems (currently being developed in Malaysia) is being considered. The systems makes use of the concept of storage of electrical energy in batteries. The advantage of this system is the low maximum demand on the generating station as well as its ability to function at long lines at low voltages up to a distance of 16 kilometres. This is an interesting area for research which can mean supply of electrical energy to the rural area for small generating systems, similar to the water supply system where each household maintain a water tank for storage purposes. This method makes possible the combination of a micro hydro system with solar and or wind energy combination or even with a bigas generator. A total integrated system can be adapted where the battery charger system is introduced.

g) Study in maximising the harvesting of water energy.

In a large number of cases in Malaysia where the rural sector has been developed there exist rivers with very good potential for energy harvesting. As these rivers are close to the Grid there is a need to study the means of maximising the harvesting of water energy and transmitting it to the National Grid. Such a Mini Hydro station normally employ induction machines and turbines with no governors. The total concept of the Mini Hydro generating station must be evaluated and researched into to ensure optimisation in terms of capital invested to the project.

Decentralisation of RN-SHP Activities.

The number of appropriate projects can be entrusted to member countries and in particular Malaysia, can be:-

i) Hybrid Governor system, electrical/mechanical.

It is thought that the hybrid governor consisting of a load controller system and a slow speed mechanical governor would be useful in reducing the cost of the governor system. In areas where there is insufficient water, the turbines would be subjected to peculiar operating condition when using a load controller. The pipeline may be subjected to fluctuation of head. It is essential that water must remain at a certain minimum level at the intake to ensure that the pipe is filled with water at all times. The hybrid governor system operates in similar manner to the load controller but the ballast load resistance banks should consist of a short time load resistances able to absorb heat from full load dumping by the generator for a

period of not more than (say) 5 minutes.This temporary load dumping means that the mechanical governor will be able to operate within this period to adjust the machinery inlet valve to the appropriate position. Little demand is made on mechanical unit in terms of time response, as well, as the load resistor banks need not be large as it function only as a short time operating time device.

ii) Micro-processor control of Power Station operation and system protection.

The country is looking forward to building of a large number of Mini Hydro stations for both rural electrification and energy harvesting aspects. Micro-processor control of power system operation and system protection would be essential as it is foreseen in the future that there will be a reduction in manpower operating these plants. There is also a need for centralised control for a group of plants within the vicinity of a control centre. Coupled to this would include the need to conduct research in terms of data, transmission and the remote control of small hydro station to ensure optimum operation of these stations. Low cost solution to these systems are necessary and need to be looked into.

iii) Use of Water resistance for testing of Mini Hydro turbines.

As mentioned earlier under the same title this subject shall be of interest to many countries as it is the means of eliminating the need for resistance banks for load commissioning of the Mini Hydro generating output. The important aspects to be seen in this area is use of high voltage (say 11kV) on the resistance banks can mean excluding heavy equipment to site. The available water at the tailrace or the river bed makes this system suitable for commissioning purposes. The research project should include building the rigs, as well as, determining the configuration and the material to be used. A certain desired standard can be achieved from this equipment.

iv) Development of turbines for local manufacture.

This covers projects that can be entrusted to member countries, as mentioned earlier, as the need to manufacture turbines in order to cut down costs of such an equipment in the developing countries. In particular OLADE design should be considered as a basis for starting.

Available Experts in Malaysia.

As far as Mini Hydro is concerned, the N.E.B's Mini Hydro department is known to have experts in Malaysia and most staff members at the engineering level are competent in many areas. This includes project management, commissioning of power station, designing of power station, reconnaisance survey, computer analysis on Mini Hydro systems, etc.

Consulting Companies in similar line.

The N.E.B has inhouse Consultancy in the Mini Hydro Department pertaining to the subject. The employment of outside Consultants is discouraged due to the nature of work and the cost involved. It is expected in the future that local Consulting Companies would be called to participate and be trained in several aspects of the Mini Hydro technology which has been developed by the Mini Hydro Department of the N.E.B. for use in particular in Peninsular Malaysia.

Equipment Manufacturers.

There are few equipment manufacturers in the country mostly engaged in large scale engineering works. These manufacturers are able to fabricate and design where drawings are available.

Civil Construction Companies.

Large number of civil construction companies have participated in the Mini Hydro programme and are available for construction of Mini Hydro projects.